SCIENCE

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MARIHUANA

By Professor ROGER ADAMS

UNIVERSITY OF ILLINOIS

THE term "marihuana" is commonly used to represent any part of the hemp plant or extract therefrom which induces somatic and psychic changes in man.

The hemp plant has been known since remote antiquity, having originated in central Asia and spread into practically all countries of the world. For centuries, the fiber of the plant has been used for clothing and rope; the seed have been pressed for oil. The oldest known reference to the hemp plant is in a Chinese treatise, "Rh-ya," written in the fifteenth century B.C. That hemp contains an intoxicating principle has also been known for centuries and records of this fact date back to 1000 to 1500 B.C. The medicinal action is mentioned in Sanscrit, Hindu and Chinese medical treatises published about the beginning of the Christian era. Hundreds of other references during the past nineteen hundred years discuss the physiological action of this plant.

Hemp is an herbaceous annual growing three to eighteen feet in height, depending on soil and climate. Botanically it belongs to the genus *Cannabis,* of which there is only a single species, *Cannabis sativa,* occurring in a few varieties; *Cannabis indica* is one of these. When the female plant is about to flower, the tops, which have large quantities of hairs, become covered with a multitude of pluricellular glandulose hairs. These appear as minute glistening points and are so numerous that the tops appear to be shining with dew. The tops are very sticky and when pressed emit a strong mint-like smell. The resin often spreads to the surface of the leaves or branches. It is largest in amount when flowers begin to appear and continues

to form until the seeds are mature—it ceases when the seeds are ripe. Botanists have suggested that the resin is formed as a varnish to protect the seed while the sap is providing the fertilized ovules with the elements necessary for maturation. The amount of resin depends almost entirely on the climate, the largest, as might be expected, in hot dry climates such as Chinese Turkestan and smallest in temperate climates where there is plenty of moisture. The morphological characteristics of *Cannabis* are modified very easily—one variety to another—merely by change in climatic conditions. The resin appears to contain most of the intoxicating principle of the plant. The male plant during flowering also exudes a certain amount of resin but much less than that produced by the female plant.

In the far East the resin (called charas) was in the early days collected from the uncut plant in several ways. Men wearing leather coats walked through the hemp and the resin stuck to the leather from which it was scraped. Sometimes sticks with leather strips attached to the end were drawn over the flowering tops. The tops were sometimes rolled in the hands and the resin scraped from the hands onto a receptacle. From cut plants, the tops were pressed between cloths or rubbed between fine mattings. By any of these procedures, a dark resinous mass was obtained, which was purified somewhat by kneading with a little water to remove dirt and extraneous material and then stored in a dry atmosphere, since it deteriorates when damp.

The modern method, such as is used at the present time in Chinese Turkestan, consists in cutting and drying the female flower heads, crushing in the hands to a powder and sieving so that it attains the fineness and consistency of sand or sawdust. This powder is stored in rawhide bags for four or five months during the winter. With the onset of hot weather the material is taken out and exposed to the sun for a short time, sufficient to allow the resin to melt. It is stored again in hide bags of ten-pound to fourteen-pound capacity. After a few days the agglutinated mass is again taken out and kneaded well by means of wooden rods so that a certain amount of oily matter appears on its surface. The process of kneading is continued until each bag yields about one or two pounds of oil. At this stage the charas is transferred to fresh bags and is ready for sale. The product consists of a greenish-black mass with a peculiar and characteristic odor.

Another commonly used East Indian hemp product called bhang consists of the specially dried leaves and flowering shoots, chiefly of the female plant. The process is merely to cut and dry the plants and to separate therefrom the leaves by striking against a block of wood.

Another product is ganja. In Eastern Bengal at the present time hemp is cultivated for the production of this material. As the female plants begin to form the resin, all the large leaves on the stems and branches are removed. The smaller leaves and the brackets of inflorescence become agglutinated into a resinous mass. The plants are then cut about six inches from the ground and exposed to the rays of the sun for a few hours. The redundant portions of the stem which do not bear flowering heads are then cut off and those bearing flowering heads are arranged in a circle with the heads directed toward the center and overlapping each other. Treading and kneading is commenced. While holding the plant tight with the left foot, the laborers press down and trample with the right foot. The process is continued until the narcotic resin is pressed firmly among the flowers in the desired form. Fresh bundles are placed over those which have been already pressed and the treading is repeated. This goes on until the ring is about a foot in height after which the flowering twigs are removed. The resulting flat resinous mass is known as flat ganja.

Ganja and charas, admixed with tobacco, are generally smoked, while bhang is usually taken by mouth in the form of a beverage or confection. In northern Africa, the hemp tops and leaves are often mascerated with water to a fluid paste and swallowed whole. Frequently they are extracted with alcohol and the residues from the solvent admixed with jams. The powdered tops and leaves sometimes are mixed with crushed nuts as a stuffing for dates, Turkish paste or in cakes; or mixed with nuts, spices, oil and chocolate to a thick paste, which is chewed.

In the United States and in several other countries, the tops of the flowering plants are cut and dried, the coarse material removed and the product chopped to the proper particle size for incorporation in cigarettes. This is the form of hemp most commonly observed in illicit distribution in this country.

The names for hemp preparations are very numerous. In addition to those already cited, should be mentioned in particular the term, hashish, which is in common usage.

There is no satisfactory bioassay method for determining the potency of marihuana. The best procedure in animal testing is administration to certain types of dogs, after which the character and degree of the incoordination, particularly of the hind legs, are observed. This very subjective method gives information as to the intoxicating power of the test sample but furnishes no indication as to the active principle content. Decerebrated cats are not affected; it thus may be concluded that marihuana affects the cerebral hemispheres and therefore poisons the intellect.

The most careful study of the effect of marihuana upon humans has been made upon educated Europeans. An extensive survey of marihuana addicts

among native North Africans and East Indians also has been reported. The general effect of marihuana is to weaken the individual's will, the faculty which controls, sorts out groups and correlates according to logical laws. Thus, in the case of the intoxicated subject, memory and imagination predominate, he becomes entirely absorbed in the past and the future and loses sight of the realities of the moment. *Cannabis* affects the mind most powerfully.

There are several successive phases to intoxication by hemp. The subject first feels himself strong, agile, elegant, capable of extraordinary feats of prowess. He experiences an intense desire to move about. Walking, jumping, dancing seem desirable, though he usually abstains from such action. Gradually his mind becomes filled with ideas foreign to the subject on which he is endeavoring to fix his attention. Suddenly he is overcome by absurd and irresistible laughter caused by any trifling incident, which very often is not amusing even to the slightest degree. Simultaneously, the addict needs conversation and talks excitedly. The conversation becomes more and more incoherent as the will loses its power to direct thought. Ideas well up incessantly in addicts, especially those with some education; they whirl through the brain, becoming ever more lively and striking, and are associated together in the most unexpected ways.

Gradually, as the action of the drug progresses, exact notion of persons and neighboring objects is lost, the emotions are extremely exaggerated and paradoxical. Mental confusion increases and moments of lucidity become shorter and shorter. Finally, the subject reaches the stage of a sensation of moral and physical lassitude; he wants complete silence; the least effort becomes an almost impossible exertion; the mind allows itself to be lulled into a state of apathy, indifference and complete calm. The Mohammedans called this "kif."

This state is marked by a complete change in notion of time. It appears infinitely slow, owing to the number and variety of impressions which rapidly enter the mind. These ideas, particularly those half-formed, seem innumerable, and since time is measured only by the memory of them it seems infinitely long.

The notion of space also is wholly impaired. The distance between the subject and a person standing quite near him appears tremendous. The hand seems to be separated by an enormous space from the glass it attempts to seize. Objects are seen through a mist so that outlines are indistinct and shapes are blurred. Sight and hearing are extremely acute, but the perceptions are distorted and the distortions are constantly varying. This is the stage of great suggestibility. Any impressions made on the senses immediately give rise to imaginary perceptions, illusions and hallucinations.

Succeeding this is a deep and heavy sleep. The subject upon awakening, in general, remembers what he experienced during his intoxication. Apparently a subconscious condition prevails, but the persistence of memory indicates that consciousness still subsists.

The order and the intensity of the various phenomena differ in each individual and depend frequently on the influence of outward circumstances at the moment. In most cases, an exaltation of the most common thoughts of the individual may be noted. Thus, it acts like most cerebral stimulants, including alcohol. The most intimate and secret thoughts of the marihuana subject are revealed by unconscious movements, acts, illusions and hallucinations, as well as by words.

Marihuana intoxication is accompanied frequently by disagreeable symptoms. Especially with an overdosage, and dependent on the environment, the subject before he reaches the euphoria stage may suffer excruciating pains in the head and neck and a feeling of torture. He may even imagine he is going to die and, in general, may go through a period of great anxiety. If he has an aversion to any one, his antipathy is transformed into a fierce hatred; he is convinced that he now has everything to fear from his enemies and that they are hatching some odious plot against him. There is only one step from the belief that danger is imminent. The addict often reaches this stage and becomes a prey to sudden fits of terror and irresistible criminal impulses. This accounts for certain violent reactions, sometimes murder of friends and relatives, committed under influence of the drug.

All these observations have been based, for the most part, on tests with educated Europeans who had ingested preparations through the mouth. An intensive study of North African native addicts has indicated some differences in effect from those just mentioned; thus, during the period of euphoria, a rapid sequence of amusing and witty ideas is replaced in the native by a flow of absurdities, coarse jokes and obscenities; the phase of motor excitation is little marked, possibly because of the fact that the native who desires complete intoxication always smokes reclining on cushions or mats.

The phenomena observed during hashish intoxication vary widely according to whether *Cannabis* is smoked or *Cannabis* preparations are ingested. If the resin content is approximately the same, the effects are more rapid (after fifteen minutes) when hemp is smoked than when it is swallowed (one to two hours or even longer).

The North African natives generally are smokers and usually smoke to excess. Under these conditions the reactions are prolonged and after the final sleep the subject awakens in a stupor. The use of marihuana finally leads to loss of fitness for work and

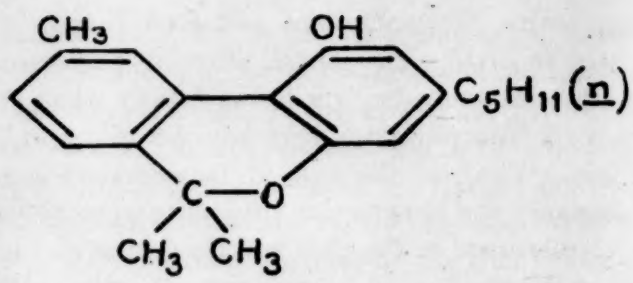
resistance to fatigue. Later, the subject is prone to headaches, loss of appetite and general degradation of the body. There is the factor of individual resistance, but the rapidity of degeneration depends on the quantity of the drug consumed.

The physiological action of marihuana may be described in most general terms as the release of inhibitions in the subject. As a consequence, an individual with natural criminal tendencies, which he controls under ordinary conditions, will commit crimes when under the influence of the drug. It is pretty securely established that this drug itself is not an aphrodisiac. It is impossible to predict the reactions in any particular subject. An exact knowledge of the intoxication of marihuana and its deleterious effects will have to await carefully controlled clinical experiments.

Ordinarily marihuana is not considered an addiction drug in the same sense as morphine, since the sudden cessation of the use of hemp does not give rise usually to the disquieting phenomena that accompany privation in the case of other narcotics. Its consumption in the United States, which had for several years increased, has recently been effectively checked.

The chemistry of marihuana is complicated and very confusing. Between 1840 and 1895 most of the chemical work consisted in rather unsuccessful attempts to find tests which would provide a means of identifying the presence of marihuana or an extract. In 1896, Wood, Spivey and Easterfield extracted hemp with petroleum ether and distilled from the extract a high-boiling fraction which apparently contained most of the active principle. This they called "red oil" because of its appearance. They were able to isolate from this oil by means of acetic anhydride a pure crystalline acetate from which by hydrolysis a straw-colored oil resulted, called by them cannabinol. For several decades, cannabinol was supposed to be the active principle of marihuana until finally it was proved otherwise. These early investigators contributed some facts toward the constitution of cannabinol but left the problem far from complete.

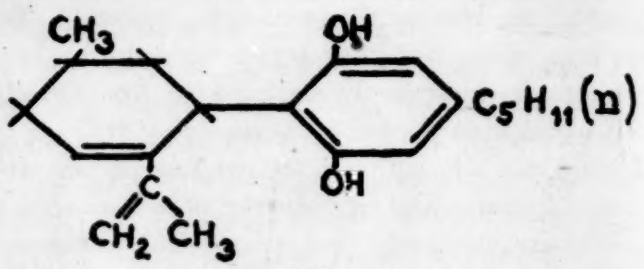
In spite of many attempts, no other investigators were successful in repeating the isolation of cannabinol until 1932, when Cahn again obtained this compound. He performed a series of brilliant researches from which he deduced a structure dubious in respect merely to the position of the hydroxyl and *n*-amyl groups. Just recently in the University of Illinois laboratories researches led to the postulation that the hydroxyl and *n*-amyl groups must occupy positions different from those suggested by Cahn. This new formula was demonstrated to be correct by an unequivocal method of synthesis. Cannabinol is 1-methyl-3-*n*-amyl-6,6,9-trimethyl-6-dibenzopyran and has structure I.



I

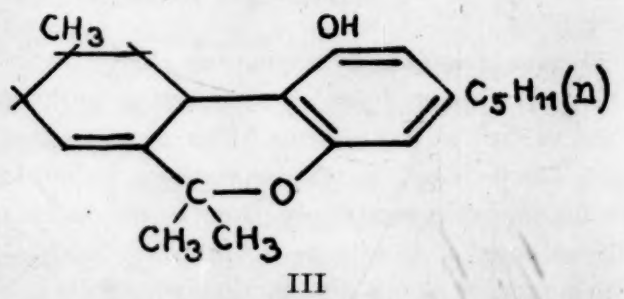
Most of the chemical work in the past has been done on charas. The experiments in the University of Illinois laboratories were performed with an extract from Minnesota wild hemp. From the red oil from this source, cannabinol has been isolated by a new procedure and also another pure compound, cannabidiol. Both substances were obtained in crystalline form. Cannabidiol composed about 45 per cent. of the red oil in hand and cannabinol about 15 per cent.

The study of the structure of cannabidiol is not yet complete, but the formula shown in II is doubtful only in respect to the position of the double bond in the left-hand ring. Cannabidiol, like cannabinol, is physiologically inactive.



II

Observation of structures I and II makes it appear likely that cannabidiol is a precursor of cannabinol. Thus, in the plant cannabidiol might isomerize readily to a tetrahydrocannabinol (III) which upon oxidation would be converted to cannabinol (I).



III

Such a series of reactions has now been consummated in the laboratory and thus confirms the probability that the plant reactions are similar.

Of peculiar interest and importance is the fact that the tetrahydrocannabinol formed by isomerization of the cannabidiol with various acidic reagents may be obtained in two forms depending on the reagent and physical conditions used in the reaction. One has a specific rotation fairly constant at about $-160°$ and the other at about $-240°$. The evidence is that the

structures of these differ merely in the position of the double bond or possibly stereochemically. The lower-rotating form has a very high marihuana activity, many-fold that of purified red oil. The higher-rotating form is less active than the lower-rotating. Both the tetrahydrocannabinols are hydrogenated to a single hexahydrocannabinol of specific rotation −70°, which is also physiologically active. It seems probable that the marihuana activity of red oil is due to one or more of these substances.

Several methods have been devised and successfully used for synthesis of tetrahydrocannabinols from simple starting materials. Homologs and analogs are also available through the new procedures. The possible marihuana activity of these compounds is now being tested.

Recently Todd has isolated from red oil in the form of a derivative a substance he calls cannibol. No information regarding its chemical characteristics is yet available.

Haagen-Smit and his coworkers reported a few weeks ago the isolation from red oil of a crystalline compound which has marked physiological activity. No information on the chemistry of the compound has yet been published.

Red oil is obviously a welter of closely related chemical substances very difficult to separate from each other. It is probable in view of the researches under way in the University of Illinois laboratories that one or perhaps more than one active principle exists and that they are tetrahydrocannabinols or closely related compounds. The probability is that the substances isolated by Todd and by Haagen-Smit will be found to be similar to these in character.

Hemp is readily identified when vegetative material is available for study. Tests are also available for identifying extracts of hemp. Reliable, scientific unequivocal methods for identifying one or more active constituents in red oil, however, must await the more extended study of the pure active compounds. Only then also will it be possible to perform quantitative clinical tests in order to obtain more accurate information on the physiological and psychological action of marihuana.

THE ROYAL SOCIETY OF CANADA

By Professor D. A. KEYS

McGILL UNIVERSITY

THIS year the fellows of the Royal Society of Canada were the guests of the University of Western Ontario in London, for their annual meeting from May 20 to 22. The attendance was not as large as last year, but representatives from all parts of Canada attended and presented papers. The university buildings, situated in beautiful spacious grounds outside the city, presented a peaceful contrast to the present conditions in Europe, that visibly affected all who attended the meeting.

The presidential address, "A Study of the Organization and Work of the Royal Society of Canada," was delivered by Dr. H. M. Tory, following a complimentary dinner tendered the fellows, their wives and guests, by the City of London on Monday night, May 20. The president stated that the Royal Society of Canada differed in one respect from the similar society in England, in that it included under its organization all the intellectual movements which were deemed worthy of recognition. Thus with the Natural Science Sections III, IV and V, were associated the Literary Sections, including philosophy, literature, history and economics. After outlining the various contributions of the older sciences and literary fields of knowledge to our present western society, the lecturer concluded with the suggestion that we should at our annual meeting each year have a major symposium dealing in some form with the relations existing between the various sections. Two typical topics suggested were "The Effect of Science upon Literature in the Last Hundred Years" and "The Present State of Controversy between Science and Philosophy."

On the following evening, Dr. R. W. Boyle received the Flavelle Medal of the Royal Society for distinction in scientific subjects, in recognition of his researches, particularly on the development of "Asdics" and his work on ultrasonics. The presentation of the medal was followed by a scholarly lecture delivered by Dr. F. Cyril James, principal of McGill University, on "Science and Society," in which he traced the changes in western society brought about in the four centuries between 1475 and 1875 due to the impact of scientific discovery. He pointed out that the primary function of the social sciences is the charting for society of a course that is most appropriate in the light of the existing fund of human knowledge. Apparently the impact of science on society has not been wholly beneficial; the ethos of western society has not responded to the changes in its material environment, but if we are willing to face the major problem of deciding upon our ideals, the forces that science has placed at our disposal are sufficient to make the attainment of those ideals a practical possibility.

Section III (Chemical, Mathematical and Physical

Sciences) was held under the presidency of Professor J. A. Gray, who delivered the presidential address on "Studies in Beta and Gamma Rays," in which he outlined the early work done in Rutherford's laboratory at Manchester and the subsequent development of the theory of scattering and softening of the Gamma rays on passing through matter. Recent experimental results on the Beta ray spectra and the Gamma rays from Uranium X were presented by Dr. Gray. Five new fellows were elected to the section, Dr. A. N. Campbell, Professor P. E. Gagnon, Professor Gordon Pall, Dr. R. M. Petrie and Professor H. Grayson Smith.

Of the eighty-four papers presented to Section III, twenty-five were by title. Space permits the mention of only a few of those papers presented. Dr. S. A. Hodgson described the seismograph installation at the Lake Shore Mines, Kirkland Lake, Ont., and the results obtained in investigating the possibility of forecasting the rock-bursts which are prevalent in that mine. The results of experiments on the vibrations in aircraft, described by Dr. D. C. Rose, indicated the possibility of improvement in the design of such craft. Dr. J. S. Foster reported that he and his associates had obtained some new results in the Stark Effect, using Cu, Ni, Hg, Zn, Cd and Pb, using fields from 100 to 250 Kv/cm. R. G. Elson, Grayson Smith and J. O. Wilhelm described a new type of calorimeter for determining the specific heats of materials at liquid hydrogen temperatures. Among the results communicated, it was stated that the variation with temperature of the specific heat of manganese can be expressed by a Debye function with a characteristic temperature of 410° and a linear term 0.0042T. A very interesting investigation on the validity of the Ferry-Porter law in normal, enhanced and depressed states of visual sensibility, and the influence of stimulation of the senses of vision, hearing, taste and smell upon the sensibility of the organs of vision were reported by Dr. Frank Allen. It appears that stimulation of one sense causes a periodic rise and fall in another, the results confirming and extending the work of Kravkov. For example, stimulation of the ear by sounds makes red colors appear dimmer and green brighter when no rest interval is allowed, but after a rest interval of 3 minutes, the red appears brighter and the green dimmer. A number of papers on meteorology by the staff of the Meteorological Office were communicated by the director, John Patterson, who exhibited a new radio-sonde instrument by R. C. Jacobsen, now being used by the service. Dr. L. Gilchrist described geophysical results of electrical drill hole coring carried out with the assistance of A. R. Clark, and Dr. D. A. Keys gave the results of a magnetic survey on Calumet Island. Dr. D. K. Froman described a new 12-inch cloud chamber used in a magnetic field for the study of cosmic-ray mesotrons.

Among the fourteen mathematical papers read, Dr. Buchanan spoke on "Second Genus Crossed Orbits," in which he considered a special case of the restricted three-body problem. Dr. R. L. Jeffery gave a paper on the integration of functions in a complete normed sector space, in which he set forth a theory equivalent to that of G. Birkhoff. Dr. Gordon Pall delivered a paper on "Simultaneous Representation in Quadratic and Linear Forms," and among several papers read by Professor Synge, attention is drawn to a new electromagnetic energy-tensor. A direct application of the laws of conservation of energy and momentum leads to the equations of motion given by the Lorentz ponderomotive force, without the radiation term. Dr. W. L. G. Williams communicated the results of an investigation on hyperbolic trigonometry.

In the Chemistry Section Dr. E. W. R. Steacie and his students presented five papers on photosensitized reactions, in which the polymerization of ethylene was investigated, using different wave-lengths in the ultraviolet, and an estimate of the strength of the C–H bond was determined. Dr. P. Gagnon described the synthesis of some new hydrocarbons in the Indene series, and Dr. R. H. F. Manske described the structure of Hunnemanine. A large number of papers were read by Dr. R. H. Clark and his students. An examination of the phenolic constituents of the water soluble ethanolysis products of western red cedar, Douglas fir and western hemlock was made, and the oil isolated from the phenolic constituent in each case on methylation with diagomethane yielded a white crystalline compound with the same melting point as that from spruce and maple woods. Another paper described a method for the synthesis and isolation of glycuronic acid.

Professor Otto Maass was elected president of Section III and Professor J. K. Robertson, the secretary.

The feature of the meetings in Section IV (Geological Sciences) was the excellent address of the president, Professor J. J. O'Neill, on "The Exploitation and Conservation of Mineral Resources in a Balanced Development of Canada." He urged that while the mines are active in Canada's north, bringing men and money into the country, is the time to take preliminary steps toward permanent settlement; otherwise, when mines are exhausted the settlements will be deserted and become "ghost towns." Each district will have to be considered as an individual problem, and study of these problems should be begun at once. Agriculture in the few areas possible, reforestation, to be followed eventually by scientific lumbering, and the development of manufacturing industries near sources of power were some of the possibilities suggested.

Among the twenty-eight papers presented, special mention may be made of one by P. M. Hurley, C. Goodman and R. D. Evans on the investigations of the helium method of age determination. They show that the agreement between the results obtained using samples of pyroxene from specimens is much better than that obtained from determining the age from felspar. It is suggested that pyroxene retains its helium and is more suitable for such age determinations. Dr. J. E. Gill called attention to the unsatisfactory state of fault nomenclature and suggested certain improvements. As a result, a committee was appointed to study the question and report at the next meeting. J. T. Wilson summarized the results of a study of air photographs covering a large belt of the North West Territories. The investigation showed this part of the Canadian Shield to be a mosaic of fault blocks, some having horizontal movements as much as eighteen miles.

The presidential address of Section V (Biological and Medical Sciences), entitled "The Causes of Hybrid Sterility and Incompatibility," was delivered by Professor W. P. Thompson, of the University of Saskatchewan, and stressed particularly the time in the life-cycle at which the causes may operate.

A notable feature of the meeting was the group of papers on fish (and particularly on salmon). Professor A. G. Huntsman described the habits of Atlantic salmon and discussed deaths due to high water temperatures in the rivers of Eastern Canada, while Professor E. M. Walker presented the work of K. C. Fisher and P. E. Elson on temperature preference in Atlantic salmon and speckled trout. W. A. Clemens reported A. L. Pritchard's work on the age of coho and spring salmon of British Columbia and his own work on sockeye salmon in the same region. Attempts to explain the origin of kokane (a variety of sockeye salmon) were made in a paper by W. E. Ricker, reported by R. E. Foerster. The close affinities of the Coregine fishes of Canada with Siberian species were dealt with by J. R. Dymond.

Desiccation in Southern Ontario, as reflected in the decreasing mileage of streams, was the subject of a paper by A. F. Coventry, read by J. R. Dymond. This led to an animated discussion as to the causes of desiccation.

Botanical papers included one by Professor R. B. Thomson on the study of sporelings in the vascular cryptogams as a basis for the interpretation of seedling organization, another by H. B. Sifton on the development of the air spaces in the leaf of Labrador tea, and two by Professor E. H. Moss on interxylary cork in *Artemisia*. Professor G. W. Scarth summarized work on frost and drought resistance carried out with J. Levitt, B. Siminovitch and others and described the changes in the physical state of protoplasm associated with hardening.

James Miller discussed the parts played by the basal and prickle layers of the epidermis in regeneration and neoplasia, and M. L. Barr described the effect on the synapse of axon reactions in motor neurons. C. C. Macklin demonstrated that after over-inflation of the excised lung the internal septa and sheaths of the pulmonary blood vessels are similarly pneumatized. Dr. Benjamin Kropp brought forward much material to demonstrate that in spontaneous and therapeutic abortions structural abnormalities were present in the villus capillaries and villus epithelium. H. Wasteneys, B. F. Crocker and P. Hamilton reported that deuterium-labeled proteins are useful for the study of digestion in the dog. Madge Thurlow Macklin gave evidence that tumors in man have a genetic basis, and Lionel Penrose presented studies on the grandchildren of consanguineous unions. Dr. D. A. Scott discussed the structure of insulin crystals prepared from bison and human pancreases in comparison with those previously prepared from other sources. Dr. Leslie Young described his synthesis aryl hydrogen sulfates *in vitro*.

Drs. Clark, Cleghorn, Ferguson and Fowler demonstrated that adrenal insufficiency results in a decrease in extracellular fluid and in plasma volume, that the percentage decrease of the former is less than the latter and that the decrease in plasma was not sufficient to account for circulatory collapse. Dr. Bram Rose presented evidence to show that in various types of shock there is a decrease in blood histamine. Dr. N. W. Roome advanced further evidence tending to dissociate the sympathetic nervous system from shock due to hemorrhage. Professor F. R. Miller demonstrated the local effects of eserine and acetylcholine on the electrogram of the cerebellar cortex. Dr. P. J. Maloney presented further evidences of the influence of bile salts on the flocculation of toxin. Professor G. B. Reed described a semi-synthetic medium for the production of gas gangrene and tetanus toxins.

E. Horne Craigie described the area of distribution of the middle cerebral artery in birds and the form of the capillary bed of the central nervous system in *Dermophis*. J. McDunnough discussed some marine Coleophoridae, and C. McLean Fraser described hydroids of the Pacific Coast.

Other papers dealt with genetics of size (J. W. MacArthur) and the structure of homotypic and somatic chromosomes (L. C. Coleman).

Principal R. C. Wallace, of Queen's University, was elected president of the society for the ensuing year.

SCIENTIFIC EVENTS

CHEMISTRY EXHIBITS OF THE CHICAGO MUSEUM OF SCIENCE AND INDUSTRY

DR. C. ROBERT MOULTON, curator of chemistry at the Museum of Science and Industry in Jackson Park, has announced the opening of a new series of exhibits in the chemistry sequence.

In the first room of this new series are exhibits designed to show how the chemist distinguishes various kinds of matter by such properties as color, taste, flavor, odor, appearance, density, crystalline form, hardness, malleability, ductility, heat and electrical conductivity, solubility and chemical activity.

In the second room are shown the natures of, and differences between, atoms, molecules, elements, compounds, pure substances and mixtures. Here, too, is shown the history of atomic theories from ancient Greece to the present day, including the contributions of Dalton and Langmuir.

The third room contains a picturesque reproduction of a sixteenth century alchemical laboratory with its strange collections of glass retorts and odd materials, where the eternal search for the philosopher's stone to turn base metals into gold went on. Adjacent to this is a 20th century chemical laboratory furnished with the most modern equipment.

The visitor passes next through a series of exhibits, many of which he may operate by pushing a button, on the fundamental laws, relationships and classification of chemistry.

Next comes a room full of rather spectacular exhibits showing typical chemical reactions, procedures and processes such as the burning of iron in oxygen, the making and burning of gunpowder, potassium burning on water, the violent heat reaction of thermit which makes it so useful in welding, electricity used to decompose water, growing crystals by electricity and many other chemical experiments.

Here a transition occurs from chemistry as a pure science to its industrial applications. Such applications of chemistry to industry as the manufacture of salt, phosphorus and phosphates, carborundum and aloxite abrasives, industrial alcohol, carbureted water gas and coal gas are shown.

THE CONCILIUM BIBLIOGRAPHICUM

THE National Research Council is informed that the Concilium Bibliographicum, the headquarters of which have been in Zurich, Switzerland, is desirous of disposing of the materials which it has acquired since its establishment by Dr. Herbert H. Field in 1895. This is necessitated by decision to terminate the operations of the concilium this summer. The materials to be disposed of consist of valuable card indexes to biological literature for the period of existence of the concilium, arranged both taxonomically and by authors' names, and covering the fields of paleontology, general biology, zoology, microscopy, anatomy and physiology; and also the catalogue of this literature published in book form as the "Bibliographia Zoologica" (Vols. 23–43; 1912–1934), and a large library of biological periodicals.

The attention of American biologists and librarians is called to this matter, since this appears to be the final opportunity at which it will be possible to obtain the card catalogues published by the concilium, or sections of these catalogues, and since from the library of the concilium it may be possible to obtain sets of important scientific journals desired by institutional libraries in the United States.

It is suggested that any one interested in acquiring these materials address Professor Doctor Johannes Strohl, director, "Concilium Bibliographicum," Waldmannstrasse 12, Zurich, Switzerland.

INTER-AMERICAN SOCIETY OF MICROBIOLOGY

DURING the period since September, 1939, when, at the close of the third International Congress of Microbiology, the initial steps were taken for the establishment of the Inter-American Society of Microbiology, work has been actively progressing toward the formation and organization of the committees throughout Latin-America which will foster the interests of the society in their several countries. These committees will also determine the final form which the society is to take in order that it may be of the utmost service to all workers in the microbiological sciences.

The following list records the chairmen of the National Committees thus far established:

Argentina—Dr. Alois Bachman, *chairman*, professor of bacteriology, Faculty of Medical Sciences, Buenos Aires.

Chile—Dr. Eujenio Suarez, *chairman*, director of the Bacteriological Institute of Chile, Santiago.

Colombia—Dr. Bernardo Samper, director, National Institute of Hygiene, Bogota.

Costa Rica—Dr. Clodomiro Picado, bacteriologist-in-chief, San Juan de Dios Hospital, San Jose.

Cuba—Dr. Pedro Kouri, *chairman*, professor of parasitology, School of Medicine, Havana.

Ecuador—Dr. Juan Antonio Montalvan, professor of hygiene, Faculty of Medical Sciences, Guayaquil.

El Salvador—Dr. Salvador G. Aguilar, director, Laboratories of Public Health, San Salvador.

Guatemala—Dr. Carlos Estevez, *chairman*, director-general of Public Health, Guatemala.

Mexico—Dr. Jose Zoyaya, *chairman*, director, Institute of Hygiene, Popotla, Mexico, D. F.

Nicaragua—Dr. M. A. Sanchez Virgil, director, National Institute of Hygiene, Managua.

Panama—Dr. A. Vincente Mastellari, Department of Public Health, Panama.

Peru—Dr. Telemaco Battistini, *chairman*, director, National Institute of Hygiene and Public Health, Lima.

Uruguay—Dr. Estenio Hormaeche, *chairman*, professor of bacteriology, Faculty of Medicine, and associate director, Institute of Experimental Hygiene, Montevideo.

Venezuela—Dr. L. Briceno Rossi, *chairman*, formerly director of Public Health, Caracas.

In all these countries except Colombia, Costa Rica, Ecuador, El Salvador, Nicaragua and Panama, committee organizations have been completed.

In Brazil, where the first Inter-American congress is scheduled to take place, the organization of the committee is under way, as is also the formulation of plans for holding the congress. Dr. A. Fontes, director of the Institute Oswaldo Cruz, will be the president of the congress.

There remain several important steps to be taken. Among these are the following: (a) Organization of the appropriate branches of the Inter-American Society in Canada and in the United States; (b) establishment of a mutually helpful relationship between the Inter-American Society and the International Society of Microbiology, looking forward to the next congress of both societies; (c) establishment in the United States of an *Inter-American Journal of Microbiology,* to be published in English and open to contributors from all American countries. Decision on these matters should be made by the microbiological societies now existing in the United States and Canada.

F. DURAN-REYNALS,
Executive Secretary

THE AMERICAN MINING CONGRESS

IN announcing the preliminary program for the seventh annual metal mining convention and exposition of the American Mining Congress, which will be held at Colorado Springs from September 16 to 19, attention is called to the program of the government for acquiring supplies of the vitally needed "strategic" minerals. It is announced that a full session of the convention will be given over to consideration of the part which minerals play in the present emergency. Another session will study and discuss the effect of the war on supplies, international movements, domestic markets, prices, etc., of each of the principal metals.

Dr. C. K. Leith, mineral adviser to the National Defense Advisory Commission, will discuss the "Role of Minerals in the Present War," followed by authorities from the U. S. Bureau of Mines and the mining industry on the nation's needs for war minerals. Ellsworth C. Alford, counsel of the American Mining Congress, Washington, D. C., will speak on "National Defense and National Finance."

Senators James Murray, of Montana, and Key Pittman, of Nevada, will both address the meeting. Senator Murray will outline plans for the expansion of Reconstruction Finance Corporation loans for mining. Senator Pittman will address the delegates on the "Future of Gold and Silver in the Light of World Conditions." Colonel Philip B. Fleming, wage-hour administrator of the U. S. Department of Labor, will also speak.

Over a period of years, the metal mining industry has urged the Congress to amend the Wagner Labor Relations Act to provide for more equitable and just administration, and this year the industry expects to secure a full report of the activities of the special committee investigating the National Labor Relations Board from Edmund M. Toland, general counsel to this committee. Mr. Toland is expected to address the session devoted to labor problems. "Present-day Industrial Relations" will be discussed at the same session by C. S. Ching, director of industrial and public relations of the United States Rubber Company.

Progress in mine safety and health, dust control and the problem of sick absenteeism will occupy another full session. Other sessions will be devoted to reviews of the progress in mining geology, mining methods and equipment, the milling of metallic and non-metallic ores and developments in placer mining. Supplementing these discussions will be exhibits of the latest types of mining and milling equipment, participated in by nearly a hundred leading manufacturers of mining machinery. Taxation, public relations, public mineral land withdrawals and industrial uses for silver are other subjects included in the program.

THE LOS ANGELES MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

THE Pacific Coast convention of the American Institute of Electrical Engineers will be held at Los Angeles from August 27 to 30.

The address of welcome at the opening session will be given by N. B. Hinson, chairman of the convention. President R. W. Sorensen will follow with an address on "Science and Superstition"; Douglas Shearer, sound director of the Metro-Goldwyn-Mayer Studios, will also speak.

In addition to the five technical sessions and two student sessions, a technical conference will be held on the subject of governors, frequency control and load swings, with several leading engineers entering into the discussion. The subjects of the technical sessions are Protective Devices, Power Transmission and Distribution, Electrical Machinery, Instruments, Mea-

surements and the Basic Sciences. The students' sessions are to be held in the afternoons of Wednesday and Thursday. On Thursday morning Major E. H. Armstrong, of Columbia University, will give an address on "Frequency Modulation."

There will be an informal reception by the president at the Ambassador Hotel on Tuesday at 5:30 P.M. and in the evening a student counselor dinner and conference, followed by a lecture on "Comets and Meteors" at the Griffit Park Planetarium. A golf tournament is planned on Thursday and in the evening there will be a dinner at the Riviera Club, amusements and dancing.

Points of interest selected for inspection trips are as follows:

Columbia Steel Plant at Torrence.

KNX Broadcasting Transmitter.

Ship-to-Shore Radio Station of the Southern California Telephone Company.

New Receiving Station E of the Bureau of Power and Light.

Laboratories of the California Institute of Technology.

The 200-Inch Telescope at Mount Palomar.

The 200-Inch Mirror, now undergoing final polishing at the California Institute of Technology.

If conditions permit, a visit to an aircraft factory may be included, although this of course will depend on national defense requirements at the time.

Trips will also be available to the Huntington Library and Art Gallery and to see the famous stained-glass window of the "Last Supper" at Forest Lawn, as well as to Chinatown and the Olvera Street Mexican Village. Additional trips to other local points of interest will be arranged on request.

RECENT DEATHS AND MEMORIALS

DR. JAMES FLACK NORRIS, professor of organic chemistry at the Massachusetts Institute of Technology and director of the research laboratory of organic chemistry, died on August 3 at the age of sixty-nine years.

FRANK BOND, ornithologist, formerly chief of the United States Geographic Board, died on July 2 at the age of eighty-four years.

Nature reports the death of Dr. G. S. Blake, formerly geological adviser to the Palestine Government.

AT the regular meeting on July 10 of the California Academy of Sciences the program of the meeting was devoted to a commemoration of the life and work of Edward Payson Van Duzee, late curator of the department of entomology of the academy. Short addresses were made by Dr. Frank E. Blaisdell, research associate; Professor E. O. Essig, University of California; Dr. Edwin C. Van Dyke, professor emeritus of the University of California and curator emeritus of the California Academy of Sciences; Professor Charles W. Woodworth, professor emeritus, University of California, and by Director Robert C. Miller and President Frank M. MacFarland, of the California Academy of Sciences.

SCIENTIFIC NOTES AND NEWS

DR. EUGENE VAN CLEEF, professor of geography at the Ohio State University, has received a special award from Delta Phi Epsilon, the professional foreign service fraternity, in recognition of his "distinguished service in education and international relations."

C. A. ZAPFFE and Dr. C. L. Faust, of the Battelle Memorial Institute at Columbus, Ohio, have been awarded the 1940 Proctor Memorial Award of the American Electroplaters' Society for their paper on the "Metallurgical Aspects of Hydrogen in Electroplating."

JAMES W. HOOK, of New Haven, Conn., president and director of the Geometric Tool Company and of the United Illuminating Company, has been awarded the Marston Medal of the Engineering Division of the Iowa State College in recognition of "his ability as a manufacturer, his leadership in movements for sane industrial relationships, the faithful discharge of his civic responsibilities and his keen interest in community affairs."

DR. A. M. H. GRAY, physician in charge of the skin department of University College Hospital, London, and lecturer in dermatology in the Medical School, was elected on July 2 president of the Royal Society of Medicine.

DR. E. R. MARTELL, assistant dean of the School of Forestry of the University of Idaho, has been appointed head of the department of forestry and conservation of the Agricultural Experiment Station at Purdue University. He succeeds Professor B. N. Prentice, who will spend a larger part of his time in teaching.

DR. CARL NEUBERG, formerly professor at the University of Berlin, until his retirement with the title emeritus in 1937 for twelve years director of the Kaiser Wilhelm Institute for Biochemistry, has been appointed research professor of chemistry at the Washington Square College of Arts and Sciences of New York University. He will take up the work in September, following his arrival in the United States from Palestine, where he has been teaching at the University of Jerusalem.

ACCORDING to *Nature* Dr. Richard Kroner, the German Jewish philosopher, formerly professor at Dresden, Kiel and Berlin, who left Germany two years ago, has been appointed professor of logic and metaphysics at McGill University.

DR. A. RAYMOND DOCHEZ, John E. Borne professor of medical and surgical research at the College of Physicians and Surgeons, Columbia University, has been appointed chairman of the department of bacteriology.

DR. C. A. BUEHLER, professor of chemistry at the University of Tennessee, became head of the department of chemistry on July 1.

DR. JOHN R. PAUL, of the School of Medicine of Yale University, has been promoted to a professorship of preventive medicine. Dr. Leon S. Stone has been promoted to a professorship of comparative anatomy.

DR. EDWARD DAWSON DAVY, professor of pharmaceutical chemistry, has been appointed acting dean of the School of Pharmacy of Western Reserve University, filling the vacancy left by the resignation of Dean Edward Spease, who will direct the newly formed pharmaceutical department of the National Association of Retail Druggists.

DR. H. R. JOSEPHSON, for the past six years expert in forest economics at the California Forest and Range Experiment Station, has been appointed a member of the faculty of the department of forestry of the College of Agriculture of the University of California.

DR. J. MERRIAM PETERSON, head of the testing department of the Hercules Powder Company, Wilmington, Del., has been appointed assistant professor of chemical engineering at Cooper Union, New York City. He will give courses in physical chemistry and chemical engineering thermodynamics.

DR. EDWARD J. STIEGLITZ, associate professor of clinical medicine at the Rush Medical College of the University of Chicago, will join the staff of the National Institute of Health, Washington, D. C., where he will conduct clinical and experimental research on the problems of aging.

DR. CHARLES HUBBARD JUDD, consultant of the National Youth Administration for the past two years, formerly professor of education and chairman of the department of psychology at the University of Chicago, has been appointed director of student work. He is succeeded as consultant by John H. Lasher, Wisconsin state youth administrator.

ACCORDING to the *Journal* of the American Medical Association, Dr. Hiram J. Bush, of the U. S. Public Health Service, has been appointed director of the Henry R. Carter Memorial Laboratory for Malarial Research at Savannah. He succeeds Dr. Thomas H. D. Griffitts, who was transferred to Puerto Rico several months ago, as chief quarantine officer. Dr. Charles M. McGill has been acting director of the laboratory since Dr. Griffitts left.

DR. WALLACE E. RICHMOND, formerly in charge of the x-ray laboratory of the department of mineralogy of Harvard University, has been appointed x-ray crystallographer in the U. S. Geological Survey.

DR. KARL F. KREBS, who recently received the doctorate in organic chemistry at the University of Illinois, has been appointed a member of the staff of the department of research and development at Bloomfield, N. J. of the Bakelite Corporation, unit of the Union Carbide and Carbon Corporation.

THE Rockefeller Foundation has made a grant of $22,500 over a five-year period for researches in agricultural bacteriology under the direction of Dr. Perry W. Wilson, of the University of Wisconsin.

DR. BRUNO ROSSI, research associate at the University of Chicago, who was recently called to Cornell University, left Chicago for Mt. Evans, Colo., on August 5, with a party of physicists from the university. It is planned to make a study of cosmic rays at Mt. Evans, where stations will be established at widely separated heights on the mountain side. The number and velocity of the rays will be measured and photographs will be made of the showers. The headquarters of the expedition will be at the high altitude research laboratory on Mt. Evans, which was built cooperatively by the University of Denver, the Massachusetts Institute of Technology and the University of Chicago.

THE Research Laboratory of the General Electric Company at Schenectady has two visiting lecturers this summer. Professor J. G. Kirkwood, of Cornell University, winner of the American Chemical Society Award in Pure Chemistry for 1936, is giving a series of lectures on the theory of dielectric polarization. Professor H. Mark, until recently professor of chemistry at the University of Vienna and at present a member of the staff of the Polytechnic Institute of Brooklyn, will present a course on high polymers. In addition to giving the graduate courses, the visitors will discuss work in their fields with members of the laboratory staff.

DR. JAMES H. KIMBALL, director of the U. S. Weather Bureau in New York City, was the guest lecturer at the opening of "Weather or Not" on August 1 at the Hayden Planetarium of the American Museum of Natural History.

THE annual meeting of the Corporation of the Marine Biological Laboratory will be held in the auditorium of the Laboratory at Woods Hole, Mass., on

Tuesday, August 13, at 11:30 A.M., for the election of officers and trustees and the transaction of such business as may come before the meeting.

A SUMMER Intensive Training Course in General Semantics will be held from August 23 to 30 at the Institute of General Semantics, Chicago. The work will conclude the summer schedule and will be under the direction of Dr. Alfred Korzybski. Information and an outline of the program can be obtained from M. Kendig, educational director, Chicago.

AT a special meeting of the Research Council on Problems of Alcohol of New York City on July 9, six types of membership, each requiring annual dues, with the exception of life membership, were inaugurated. These types of membership are as follows: regular membership, $5 per year; contributing membership, $10 per year; supporting membership, $25 per year; sustaining membership, $50 per year; patron, $100 or more per year, and life membership, $1,000 or more. Each membership includes a subscription to the *Quarterly Journal of Studies on Alcohol,* which has become the official organ of the council.

THE librarian of St. Bonaventure College, New York, the Rev. Irenaeus Herscher, reports that the college has arranged to acquire a microfilm library of 26,143 volumes, products of the printing press from the time that the first book was printed in English, in 1474, to 1640, covering almost two hundred years. The completion of this microfilm library was to have taken three years, but it is now estimated that it will take another year. Already 200,000 pages of the books have been photographed, and these will be available before the college reopens on September 17. The volumes being microfilmed represent many millions of dollars where value can be estimated. Many of them are considered priceless. The pages of the books are reproduced on the reels of film and they are shown full size and clearly readable on the screen of a reading machine.

Two grants have been made to the Louisiana State University by the General Education Board. One, of $5,000 a year over a five-year period beginning on July 1, is to provide visiting teachers in the department of sociology. The other is a $9,500 grant for 1940–41 to defray expenses of courses in techniques of population research in the department. The courses are to be taught by Dr. Warren S. Thompson, director of the Scripps Foundation for Research in Population Problems at Miami University, during the second semester of the session. The grant makes provision for six fellowships to be used at Louisiana State University during Dr. Thompson's period of service. Under the terms of these grants and in accordance with plans developed by Dr. T. Lynn Smith, head of the department of sociology, the university will be enabled in each year to obtain as a visiting professor a young sociologist of decided promise from one of the other universities. Also additional time will be afforded the members of the faculty for research.

ACCORDING to the *Geographical Journal,* London, the Montreal Society of Geography, of which M. François Vézina is president and Dr. Benoît Brouillette is secretary-general, is housed at the École des Hautes Études Commerciales of the University of Montreal, and will work in cooperation with that body. In addition to stimulating public interest in geography by lectures and excursions, it aims particularly at encouraging geographical research, the teaching of geography from the primary school to the university on modern lines and the study of the regional geography of Quebec and the national geography of Canada. The geographical nomenclature of the Province of Quebec will also form another sphere of work. The society proposes to establish a specialized library, and, when funds permit, to publish a bulletin. Considerable support has already been received, and several meetings have been held.

ARRANGEMENTS have been made between the various Imperial Agricultural Bureaus whereby any publication upon the preparation of which two or more bureaus collaborate shall be included in a new series entitled "Joint Publications." It has been decided to regard the earlier Joint Publications on "Vernalization and Phasic Development of Plants" and "Erosion and Soil Conservation," as Nos. 1 and 2 in this series. Other joint publications produced in recent years but already out of print have not been given numbers in the series. The Imperial Bureau of Plant Breeding and Genetics and the Imperial Bureau of Pastures and Forage Crops have now produced Joint Publication No. 3, entitled "The Breeding of Herbage Plants in Scandinavia and Finland." It is a symposium consisting of a series of articles by specialists in the respective countries. G. Nilsson-Leissner, F. Nilsson, E. Åkerberg and R. Torssell contribute articles on work in Sweden, H. N. Frandsen, H. Wexelsen and O. Pohjakallio on Denmark, Norway and Finland, respectively.

Nature states that sixty-six Canadian university students will take training in research in Canadian institutions under National Research Council Scholarships during 1940–41. While the majority of these students will be engaged in chemical and physical investigations, such biological studies as genetics, plant pathology, physiology and zoology will each have a quota of students. Two Special Scholarships of 1,000 dollars each will be held in the Division of Chemistry at the Na-

tional Research Council laboratories, by R. L. Cunningham and R. B. Harvey of McGill University. Four fellowships of the value of 750 dollars each, and thirty-seven studentships of the value of 650 dollars each, will be held at Canadian universities directly under the auspices of the National Research Council. With the cooperation of Canadian universities, the National Research Council is also awarding twenty-three bursaries of 250 dollars each. These bursaries are available to students of high attainments who have just graduated and are ready to take their preliminary training in research.

AT the Toronto meeting of the American Society of Biological Chemists a committee was appointed to consider the relationship of chemists to the work in clinical laboratories. The committee, consisting of Dr. William C. Rose, president elect; Dr. D. D. Van Slyke and Dr. Vincent du Vigneaud, chairman, was authorized to act for the society and has submitted the following report: The American Society of Biological Chemists wishes to express its full agreement with the policy set forth in the resolution adopted by the American Chemical Society with regard to clinical laboratories: "In order that the public may be protected the states should license individuals engaged in determining data of a chemical nature bearing upon the public health or upon which the diagnosis and treatment of disease may be based, and that the states also should approve laboratories engaged in such work and their directors, solely on the basis of adequacy and competence and without assuming that any particular degree such as doctor of medicine, doctor of philosophy or doctor of science, is in itself a guarantee of the qualifications requisite to ensure the accuracy and experience necessary to the public welfare."

DISCUSSION

BACTERICIDAL FILTRATES FROM A MOLD CULTURE*

ALTHOUGH there is a large literature on bacterial antagonism, going back to the work of Metchnikoff and culminating in the striking results of Dubos at the Rockefeller Institute, there is, to my knowledge, only one recorded case of a bactericidal product formed from a mold. In 1929 Fleming[1]—confirmed later by Reid[2]—found that filtrates from a particular *Penicillium* displayed marked inhibitory effect on the growth of many gram-positive and some gram-negative organisms, but without bactericidal effect. Gratia and Dath[3] reported a *Streptothrix* whose filtrates were highly bactericidal to a variety of bacteria.

In this laboratory a mold—tentatively identified by Dr. Charles Thom of Washington as *Aspergillus flavus*—has been found which grows readily in liquid media yielding filtrates that are definitely bactericidal for some gram-negative as well as gram-positive bacteria. A series of other *Aspergilli*—all kindly supplied by Dr. Thom—has been examined in this way, with widely varying results. Another strain of *Aspergillus flavus* was found totally inactive, while several representatives of the oryzae-flavus group, as well as a strain of *Aspergillus parasiticus,* have shown activity in one degree or another; but none has been as active as the original organism. The results with any mold are fundamentally dependent upon the medium. Various media and conditions of growth are being studied, and at the time of writing a method has been found to concentrate the active material, although nothing is yet known as to its nature. The results so far noted stem from an inherent property of the mold as against properties developed by adaptation in the sense of Dubos and of Waksman and collaborators.[4] However, attempts are being made to grow the mold on bacterial cultures as sources of nutriment with the hope of accentuating the activity already existing.

A detailed report of this work will be published as results warrant. In view of the growing interest and more numerous investigations in this field of microbial antagonism it has seemed appropriate to publish this brief record at this time.

EDWIN C. WHITE

BRADY INSTITUTE,
THE JOHNS HOPKINS HOSPITAL

* This work is being carried out with the aid of a grant from the American Association for the Advancement of Science.

1 *British Jour. Exp. Path.*, 10: 226, 1929.
2 *Jour. Bacteriology*, 29: 215, 1935.
3 *Compt. Rend. Soc. Biol.*, 92: 461, 1925.

ANTLER-EATING BY RODENTS

CARLSON'S query[1] as to the presence of an "urge" or appetite in the gray squirrel for calcium and phosphorus during pregnancy and lactation as evidenced by the eating of bone brings up a related question which may have some bearing on the case. This is a question of what becomes of deer antlers after they are shed.

It might be supposed that if the antlers persisted on the ground for several years after shedding they would become quite common on certain portions of our western range where it is heavily stocked with deer. It has been my observation through many years afield on such ranges that the antlers are exceedingly scarce. I believe this has been corroborated by many other observers. If it is actually a fact, the obvious

4 National Academy of Sciences, Washington, April, 1940. A report of this work was seen in the *New York Times* of April 24, 1940.

1 A. J. Carlson, SCIENCE, 91: 573, June 14, 1940.

implication is that the antlers disappear rapidly after being shed.

In casting about for an explanation of their scarcity, I can suggest only one possibility that would explain their rapid disappearance—that of being eaten by rodents. I have observed on a very few occasions partly eaten antlers with definite teeth-marks left to indicate the gnawing of rodents, presumably mice. Could this be the answer to the disappearance of the antlers? Could antlers serve the same purpose that bones did for Carlson's gray squirrel? Is it likely that other rodents have an "urge" or appetite to eat bones or antlers?

If antlers do actually disappear in this manner, it seems to me, there must be some wide-spread agency consuming them, and consequently they must serve as an important source of supply of minerals. Could it be possible that there is an interrelated dependency between rodents and deer or other antler-shedding ungulates?

It has occurred to me several times that I have found on the range more cases of antlers fastened to the skull than of those that have been shed. While this is clearly a case of memory I wonder if others have had similar experience. If this be true, the obvious implication is that the shed antlers disappear more rapidly than those fastened to the skull at death. If so, is there some change in the composition of the antlers that would make them more palatable to rodents when properly shed than at other times?

ANGUS M. WOODBURY

UNIVERSITY OF UTAH

THE EATING OF BONE BY SQUIRRELS

IN your issue of June 14, Professor Carlson asked for reports on the eating of bone by squirrels. The following note may be of interest. In 1928 I spent a large part of the summer in a cottage on a five-acre island in Lake Temagami, Ontario. The island is densely covered with mixed bush. Lying just outside the cabin was an old moose skull, found a year or two earlier in a stream where it had been long enough to become completely clean; this, combined with subsequent exposure to all weathers, had reduced the fleshy contents to a minimum. During this summer a red squirrel (*Sciurus hudsonicus*) regularly visited the skull twice a day, about 6 A.M. and 4 P.M., and nibbled for a few minutes at projecting parts, especially the upper edge of the orbits. When I first arrived on the island the physiological effects of the breeding season might still have been operative (assuming the animal was a female), but the practice was continued till the end of August, when this could hardly have been the case. I do not want to imply that the visits were invariable, but they were so regular as to be expected, and I have photographs of the animal on the skull. The amount removed each time was very small, but there was a real eating of bone.

A. F. COVENTRY

UNIVERSITY OF TORONTO

FIFTY HARVARD GRADUATES

CERTAIN achievements of the Harvard College Class of 1915 seem worth special consideration just now. This is the class which was graduated into World War I and its social-economic upheavals. It is the class which, having reached its twenty-fifth and mature anniversary, was the principal alumni group at the recent Harvard University graduation exercises. Again a world war was in their minds, and each individual's relations to his society's changes. Seriously they looked backward at their own careers and forward to the careers of their children.

This is what they found in their own pasts:

Seven hundred and two matriculated with the class; 90 have died; 12 have disappeared; 600 are active to-day; some 400 were able or wanted to attend their twenty-fifth class reunion.

Taking "American Men of Science" and "Who's Who in America" as measures of achievement—50 of the 600 survivors are in one or the other of those directories; 9 are in both; 19 are in "American Men of Science." Two are starred in "American Men of Science," one when he was 40 years old, the other when he was 46.

By professions, the 50 break down to 16 in academic work, 5 in medicine, 3 in law, 5 in government service, 6 in finance, 10 in business, 5 in writing.

Oldest in this group is 58 years; youngest 44; average age 47.

Average age of achievement (when a man became assistant professor, published a book, etc.) for the 50 was 33.3 years; for all the scientists, 31.4; for the 9 scientists listed also in "Who's Who" 29.8.

The plurality (24) of these 50 achievers have migrated westward from their place of birth. Seven have traveled eastward; 19 flourish in the neighborhood of birth.

Of the 50, 45 have been married, 7 divorced. Average at first marriage, 27.7. Average marriage age of those with children, 26.8; without children (10 couples) 30.8. Average number of children from productive marriages, 3.1; from all the 50, 2.2.

Of the entire 1915 class of 600, 491 have married. Each averages 2.3 children. The whole class average is 1.9. Achievers are the more family-minded. But one classmate, whom the directories do not list, has nine children. The divorce rate of the achievers is 14 per cent. (7:50), against 9 per cent. (54:600) for the whole class.

MYRON WEISS

NEW YORK CITY

SCIENTIFIC BOOKS

CLADOCERA

Studies on the Physiology, Genetics, and Evolution of Some Cladocera. By A. M. BANTA, with the collaboration of THELMA R. WOOD, L. A. BROWN and LESTER INGLE. x + 285 pp., 170 figs., 16 diagrams. Paper No. 39, Department of Genetics, Carnegie Institution of Washington. 1939.

THIS book tells the general story of results obtained in a series of studies of Cladocera which began in 1911 and continued to 1938. The immediate problem in the beginning was concerned with selection in relation to evolution. This group of animals seemed particularly favorable for a study of small heritable variations because many of the forms show considerable variations in different types of habitats. As the investigation progressed, however, the scope of the studies was enlarged to include a number of problems as shown by the headings of the twelve chapters into which the book is divided; the various topics include discussions of selection, sex intergrades, head mutations, control of male and sexual egg production, genetical studies in sexual reproduction, growth, the effect of environment, and finally the adaptation and evolution of the group.

Limited space permits only brief references to some of the more salient points. With regard to sex intergrades, *Simocephalus exspinosus* showed various stages of intergradedness and some clones produced many more individuals of this type than others; the sex reversals were always from male to female. Many of the intergrade individuals were either sterile or had a low reproductive capacity, thus leading to the conclusion that a sex intergrade stock could not survive in nature. With one possible exception, no sex reversals were found in *Daphnia longispina,* but hermaphroditic individuals were noted occasionally; they also had a low reproductive capacity and probably could not survive under natural conditions.

An excavated-head type of *D. longispina* came from a sex intergrade stock, and the character proved to be heritable in both males and females; it was found in the 250th generation following its appearance. Three elements of the environment were found to have some effect on the sex of cladocerans; temperature and quantity of food acted as general or limiting conditions, while crowding also proved effective in inducing liberal male production. Apparently male production was caused by a lowered rate of metabolism of the mother.

In the genetical studies, some culture lines remained vigorous for long periods of time under parthenogenetic reproduction. A culture of *D. longispina* remained vigorous for 14 years (680 generations), but most lines became weak after prolonged parthenogenesis. Clones of *Moina macrocopa* showed no loss of vigor over a period of 23 years (1,572 generations). Some of the declines in clones may have been due to unfavorable culture conditions, but in some cases they may have been due to dominant or semi-dominant mutations that affected vigor.

The growth studies showed that the normal life of *Daphnia longispina* consisted of 3 juvenile, 1 adolescent, and 10 to 19 adult instars, with a life span of 29 days at 25° C. The growth during the adolescent instar was unusually large, even up to a doubling of the body size. These animals increase in size for about 71 per cent. of their lives, remain at the maximum for 17 per cent. and then have a senescent decline for about 12 per cent.

Marked differences in growth rate were found in different clones and even among individuals of the same clone. Such variations were especially noticeable in the slowly developing dwarf clones which produced individuals phenotypically different from one another, though the members of the clone were all genotypically alike. Apparently the dwarf clones were due to some heritable defect in their assimilative mechanism.

The final chapter deals with the adaptation and evolution of the Cladocera. Parthenogenesis is pointed out as one of the most striking characteristics of the group. It enables them to quickly and abundantly populate temporary habitats, such as seasonal pools, as well as permanent bodies of water when conditions are favorable. When crowding or other unfavorable conditions overtake them, they are able to reproduce sexually and form resistant eggs which are able to withstand severe environmental conditions and thus provide for the survival of the various forms.

The book is a fitting climax to the arduous and painstaking studies that have been carried on for such a long period of time.

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REPORTS

THE NATIONAL RESEARCH COUNCIL COMMITTEE ON MATHEMATICAL TABLES AND AIDS TO COMPUTATION

SINCE this committee has been especially active during the past twelve months, it seems desirable that some account of this activity and of the committee's plans should be more generally known. At present its chief aim is to prepare a series of reports on pub-

lished and unpublished mathematical tables of importance for current research in different fields. This does not, of course, imply a survey of every table in each field, but only those of special importance for research at the present time, though it may occasionally be found that old tables of this nature have not been replaced by anything of recent date.

Each report is to contain the following three major divisions:

I. Descriptive survey of all tables in accordance with a carefully prepared plan of classification of the field.

II. Bibliographic details of every table, published or unpublished, which is referred to in the survey. These are alphabetically arranged and refer to every edition and every translation.

III. List of all known errata in every table listed. This feature must frequently be of exceptional value to the worker.

From the descriptive survey one may at once learn every table in any particular part of a field and the exact range of each table. The bibliography indicates the periodicals, books, pamphlets or manuscripts where the tables may be found, and also the location of every manuscript. The new edition of the "Union List of Serials" will soon indicate the libraries of the United States and Canada where the serials mentioned may be found. The committee made up a list of 37 libraries (2 in Canada and the others in 22 states) whose exact holdings, of all books and pamphlets mentioned in each report, are to be indicated.

The present membership of the committee is as follows:

Executive Committee:

Professor R. C. Archibald, *chairman*, Brown University
Professor H. Bateman, California Institute of Technology
Doctor L. J. Comrie, Scientific Computing Service Ltd., London, England
Professor H. T. Davis, Northwestern University
Professor D. H. Lehmer, University of California
Professor H. S. Wilks, Princeton University

Professor S. H. Caldwell, Massachusetts Institute of Technology
Professor W. G. Cochran, Iowa State College of Agriculture and Mechanic Arts
Professor A. T. Craig, State University of Iowa
Professor C. Eisenhart, University of Wisconsin
Professor J. D. Elder, University of Michigan
Professor P. W. Ketchum, University of Illinois
Doctor A. N. Lowan, U. S. Works Progress Administration, 475 Tenth Ave., New York City
Doctor J. C. P. Miller, University of Liverpool, England
Doctor W. A. Shewhart, Bell Telephone Laboratories, New York City
Doctor G. R. Stibitz, Bell Telephone Laboratories, New York City
Professor I. A. Travis, University of Pennsylvania

The present 22 sections (A . . . Z) of different fields, and the six subcommittees already chosen to survey twelve of these sections are as follows:

A. Arithmetic. Mathematical Constants
B. Powers
C. Logarithms
D. Circular Functions
E. Hyperbolic and Exponential Functions
Professor Davis, *chairman*
Professor Elder
Professor Ketchum
Doctor Lowan

F. Theory of Numbers
Professor Lehmer

G. Higher Algebra
Professor Lehmer

H. Numerical Solution of Equations
J. Summation of Series

I. Finite Differences
K. Statistics
Professor Wilks, *chairman*
Professor Cochran
Professor Craig
Professor Eisenhart
Doctor Shewhart

L. Higher Mathematical Functions
M. Integral Tables
Professor Bateman

N. Interest and Investment
O. Life Insurance
P. Engineering
Q. Astronomy
R. Geodesy
S. Physics
T. Chemistry
U. Navigation

Z. Calculating Machines and Mechanical Computation
Doctor Comrie, *chairman*
Professor Caldwell
Professor Lehmer
Doctor Miller
Doctor Stibitz
Professor Travis

It is expected that in the near future other sub-

committees will be organized for dealing with further sections. Professor Lehmer's Report on Section F—Theory of Numbers is now in the press and will probably occupy about 175 pages.

I should be especially glad to receive information from any one with reference to mathematical manuscript tables, of value for our survey, which may be in public or private hands.

I have stated that the chief aim of the committee was to prepare for publication by the National Research Council a series of reports such as are described above. But another aim of almost equal importance is to publish a series of new mathematical tables which the committee has reason for believing to be of importance for different fields of research. In order to make such publications possible the Rockefeller Foundation, last May, appropriated $15,000 to the National Research Council to be used for the establishment in the Division of Physical Sciences of the Council of a revolving fund "for the publication of mathematical tables and aids to computation and bibliography of such tables," under the direction of the Committee on Mathematical Tables and Aids to Computation.

RAYMOND CLARE ARCHIBALD

BROWN UNIVERSITY,
JUNE 26, 1940

SPECIAL ARTICLES

RADIO-IRON IN PLASMA DOES NOT EXCHANGE WITH HEMOGLOBIN IRON IN RED CELLS[1, 2]

RADIO-IRON gives the investigator a relatively simple and accurate method of tracing the course of iron absorption and transfer within the body. When iron is absorbed in the anemic dog it heaps up rapidly in the blood plasma,[3] reaches a peak and falls close to the base line in 6 to 12 hours. Within 4 hours after feeding, radio-iron is found in significant amounts in the hemoglobin of red cells of the anemic dog.[4] When values shift with this rapidity, obviously we must be certain that the iron within the hemoglobin of these circulating cells does not exchange with the plasma radio-iron in the dog under investigation. The following experiments bear on this important point and give evidence that the iron bound in hemoglobin is fixed and incapable of exchange with plasma radio-iron or artificial solutions of radio-iron.

The following experimental procedure was employed. Iron containing the radioactive isotope was fed to a fasting anemic dog. One and a half hours later, 90 ml of blood was withdrawn into 20 ml of isotonic oxalate. Red cells were removed by centrifugalization. One aliquot of 10 ml of plasma was ashed for radioactive iron determination. Six other aliquots were added to washed red blood cells obtained from 10 ml of blood of animals whose blood levels ranged from severe anemia to normal. The suspensions were kept at 37° C. for 24 hours with frequent agitation. The cells were removed in the centrifuge and washed three times with saline. Cells were laked and stroma precipitated by re-establishing isotonicity followed by centrifugalization. The supernatant solution of hemoglobin was ashed for radioactive iron determination.

Activity determinations were made using the Geiger-Müller counter as described in previous publications.[3]

The control plasma aliquot had an activity of 5.3 counts per minute above the background of 3.7 counts per minute on our scale-of-four counter.

In each case measurement of activity of the iron separated from the hemoglobin after the exchange experiment showed close to background rate of counting, indicating that no exchange within the accuracy of measurement had occurred.

From statistical considerations it is considered that in these individual experiments exchange could have been as high as 15 per cent. without having been detected, although in the average of six experiments it is certainly much less than this.

TABLE 1

LACK OF EXCHANGE BETWEEN THE IRON OF HEMOGLOBIN IN RED CELLS AND PHYSIOLOGICALLY BOUND PLASMA RADIO-IRON

Dog	Hematocrit	Hemoglobin level	Activity found counts per min.		Remarks
			Hemoglobin	Plasma	
	%	gm %			
39–196	51.7	18.0	0.2	4.4	Normal adult
39–53	28.9	8.0	0.0	4.8	Anemic
39–144	32.2	10.5	0.0	5.5	Anemic, protein depleted
37–227	18.4	5.4	0.0	4.8	Anemic
39–80	17.3	4.8	0.0	5.9	Anemic, bile fistula
39–169	32.5	10.9	0.4	6.1	Anemic, receiving liver in diet

Control plasma shows an activity of 5.3 counts per minute.

An experiment was carried out to determine whether there was any exchange between hemoglobin in solution and inorganic iron in solution. Ninety ml of

[1] From the Departments of Pathology and Radiology, the University of Rochester School of Medicine and Dentistry, Rochester, N. Y.

[2] We are deeply indebted to Professor E. O. Lawrence and members of the Radiation Laboratory of the University of California for the radioactive iron used in these experiments, and in particular to Dr. M. D. Kamen, who was directly responsible for preparing the isotope.

[3] P. F. Hahn, W. F. Bale, E. O. Lawrence and G. H. Whipple, *Jour. Exp. Med.*, 69: 739, 1939.

[4] L. L. Miller and P. F. Hahn, *Jour. Biol. Chem.*, 134: 585, 1940.

blood from dog 38–112, an anemic animal with no circulating radioactive iron, was centrifugalized. Plasma was discarded. The cells were laked in distilled water and the stroma precipitated partially by the addition of 18 per cent. sodium chloride. The supernatant solution, largely hemoglobin, was separated and 2 ml of iron labelled with the radioactive isotope in the form of ferric ammonium citrate were added. After standing in the refrigerator for 24 hours the mixture was poured into aluminum cream to precipitate remaining stroma and any other protein material other than hemoglobin. Perhaps 15 per cent. of the original hemoglobin was lost in this step. The filtrate was poured into an equal volume of 10 per cent. trichloroacetic acid to precipitate hemoglobin and this precipitate was washed and ashed for determination of radioactivity.

EXPERIMENTAL DATA

Iron content of hemoglobin from 90 ml of blood	22 mg
Labelled iron added as ferric ammonium citrate	0.34 mg
Activity of radioactive iron added	66 counts per min.
Net activity of radioactive iron in hemoglobin	0.1 counts per min.

The amount of labelled iron found in the hemoglobin is within the experimental error. It is estimated that radioactive iron equal in activity to 0.4 counts per minute might have been present and escaped detection. This sets an upper limit of 1 per cent. on the amount of exchange which might have taken place and escaped detection under the conditions of the experiment.

These findings are supported by other experiments in which solutions of hemoglobin were tested with artificial solutions of radio-iron in plasma. There was no evidence of any exchange between the hemoglobin iron and the radio-iron in solution. These experiments were done before the final tests recorded in Table 1.

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VISCOSITY AND THE SHAPE OF PROTEIN MOLECULES

IN some recent publications,[1, 2, 3, 4] attempts have been made to interpret protein viscosity data in terms of the asymmetry of the molecules. This has been done by applying equations developed by Burgers[5] and Eisenschitz,[6] or by Kuhn,[7] on the assumption that there is no orientation of the molecules. The discrepancies between these values for the asymmetry and the values obtained by applying the equations of Perrin[8] to sedimentation velocity and diffusion data are considerable. It has been suggested that the differences arise from the failure to consider the effects of hydration. Recently the hydrodynamic behavior of ellipsoids has been reconsidered by Simha.[9] The results obtained seem to yield better agreement for the asymmetries of various proteins than previous equations without any assumption of hydration.

In the expression for the specific viscosity at infinite dilution,

$$\eta/\eta_0 - 1 = \nu c \qquad (1)$$

(where c is the volume fraction of the solute), ν is a function of the axial ratio, ρ, of an ellipsoid of revolution. Table I gives the numerical values of the factor

TABLE I

$1/\rho$ or ρ	ν elongated	ν flattened	$1/\rho$ or ρ	ν elongated	ν flattened
1.0	2.50	2.50	20.0	38.6	14.80
1.5	2.63	2.62	25.0	55.2	18.19
2.0	2.91	2.85	30.0	74.5	21.6
3.0	3.68	3.43	40.0	120.8	28.3
4.0	4.66	4.06	50.0	176.5	35.0
5.0	5.81	4.71	60.0	242.0	41.7
6.0	7.10	5.36	80.0	400.0	55.1
8.0	10.10	6.70	100.0	593.0	68.6
10.0	13.63	8.04	150.0	1222.0	102.3
12.0	17.76	9.39	200.0	2051.0	136.2
15.0	24.8	11.42	300.0	4278.0	204.1

ν for values of $1/\rho$ and ρ from 1 to 300. These values have been applied to the same viscosity data as those used by Polson[1] and by Mark and Simha.[2] In Table II the axial ratios are compared with those from sedi-

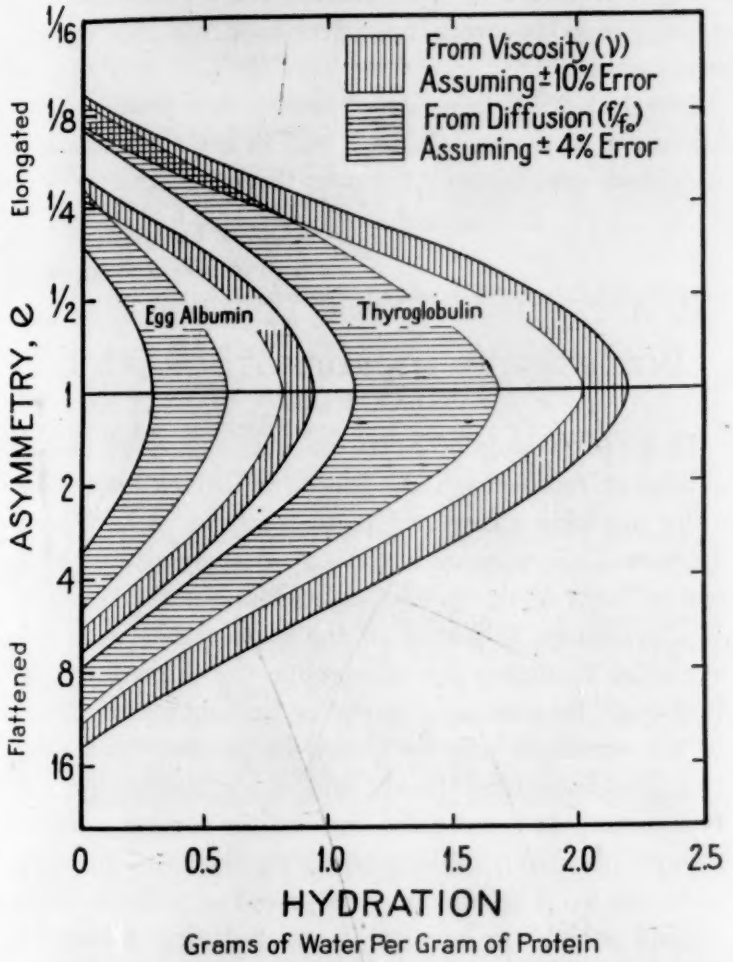
TABLE II

Protein	f/f_0	ν	$1/\rho$, elongated		ρ, flattened	
			Diffusion	Viscosity	Diffusion	Viscosity
Egg albumin ...	1.17	5.7	3.8	5.0	4.0	6.7
Serum albumin..	1.25	6.5	5.0	5.6	5.4	7.7
Hemoglobin	1.16	5.3	3.7	4.6	3.9	6.0
Amandin	1.28	7.0	5.4	6.0	6.0	8.5
Octopus hemocyanin	1.38	9.0	7.2	7.3	8.2	11.4
Gliadin	1.60	14.6	10.9	10.5	13.6	21
Homarus hemocyanin	1.27	6.4	5.2	5.5	5.8	7.5
Helix pom. hemocyanin	1.24	6.4	4.8	5.5	5.2	7.5
Serum globulin .	1.41	9.0	7.6	7.3	8.9	11.4
Thyroglobulin ..	1.43	9.9	7.8	7.9	9.2	12.7
Lactoglobulin ..	1.26	6.0	5.2	5.1	5.7	6.9
Pepsin	1.08	5.2	2.5	4.5	2.6	5.8
Helix hemocyanin pH 8.6	1.89	18.0	16.6	12.0	23.9	26

1 A. Polson, *Koll. Zeits.*, 88: 51, 1939.
2 Mark and Simha, *Nature*, 145: 571, 1940.
3 V. L. Frampton and H. Neurath, SCIENCE, 87: 468, 1938.
4 M. A. Lauffer, SCIENCE, 87: 469, 1938.
5 J. M. Burgers, "Second Report on Viscosity and Plasticity," Amsterdam, 1938.
6 R. Eisenschitz, *Zeits. physik. Chem.*, A163: 133, 1933.
7 W. Kuhn, *Zeits. physik. Chem.*, A161: 1, 1932.
8 F. Perrin, *Jour. Phys. et Rad.*, 7: 1, 1936.
9 R. Simha, *Jour. Phys. Chem.*, 44: 25, 1940.

mentation and diffusion. The agreement seems to be generally good on the assumption that the protein molecules can be approximated by rigid elongated ellipsoids.

The Asymmetry of Protein Molecules Calculated from Viscosity and Diffusion Assuming Various Degrees of Hydration



In an attempt to evaluate the importance of hydration and to determine whether any choice can be made between the elongated and flattened shapes, values of ρ were calculated from viscosity and from sedimentation and diffusion, assuming that the protein carried varying amounts of water. It also seemed desirable to consider the influence of experimental error, so that the values of f/f_o were taken to be subject to $\pm$ 4 per cent. error, and values of ν to $\pm$ 10 per cent. error. The areas included between pairs of such curves would then include the possible choices for shape and hydration. Such curves for egg albumin[10] and thyroglobulin are given in Fig. 1. They were chosen as well-characterized examples of fairly symmetrical and fairly asymmetrical molecules. The shape of these curves is such that they never cross sharply, but it can be said that, for these two cases, hydration greater than 0.5 grams of water per gram of protein, and the flattened shape, seem relatively improbable.[11]

It should be further emphasized that all the equations mentioned above only apply to measurements of the viscosity which are made in the region of complete Brownian movement. Any orientation will reduce ν, and hence $1/\rho$ or ρ if these equations are misused. This may be well illustrated by the case of tobacco mosaic virus, where measurements in capillary tube viscometers give values of ν of about 80.[3, 4] However, this must be much too low, as it is known that double refraction of flow is obtained under such conditions of flow. Robinson[12] has made measurements in a Couette viscometer and found that ν approaches 1,500 as the velocity gradient approaches zero. This would correspond to an axial ratio of about 160, assuming a rod-like shape.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTRONIC RELAY FOR HEAT CONTROL[1]

THERE are a large number of biological and chemical processes whose study requires the temperature of the materials to be held within very narrow limits. While several methods for temperature control have been described they have the disadvantage of being rather elaborate and expensive when the temperature is to be held to 0.02° C. To overcome these disadvantages, we developed the electronic relay whose circuit is given in Fig. 1. It controls a bath temperature to 0.02° C.,[2] requires only a 115-volt power source which can be either a-c or d-c, and permits only a few microamperes to pass through the thermoregulator contacts. The parts of the apparatus were bought at a radio shop for less than six dollars.

The device operates as follows: When the temperature of the thermostat is too low, the circuit through

[1] Contribution from the Department of Electrical Engineering and the Research Laboratory of Physical Chemistry, No. 451, Massachusetts Institute of Technology.

[10] The value of ν chosen for egg albumin for this calculation was 5.4, rather than 5.7 as used by Polson. The choice of this value is discussed by Oncley, *Proc. N. Y. Acad. Sci.*, in press.

[11] For a discussion of solvation on the basis of viscosity measurements, see also H. Mark and R. Simha, *Jour. Phys. Chem.*, in press.

[12] J. R. Robinson, *Proc. Roy. Soc. Lond.*, A170: 519, 1939.

[2] Heidt, *Jour. Am. Chem. Soc.*, 61: 3455, 1939.

its thermoregulator is open; there is thereby no electrical connection between points A and B, and the control grid of the type 25L6 tube is at approximately the same potential as the cathode. Under this condition the tube has a low plate resistance, the plate current is very large and the relay (Dunco, Catalogue No. ABTX1) is energized, causing the relay contacts to close. The closed contacts permit current to flow through the heater in the thermostat, thus raising its

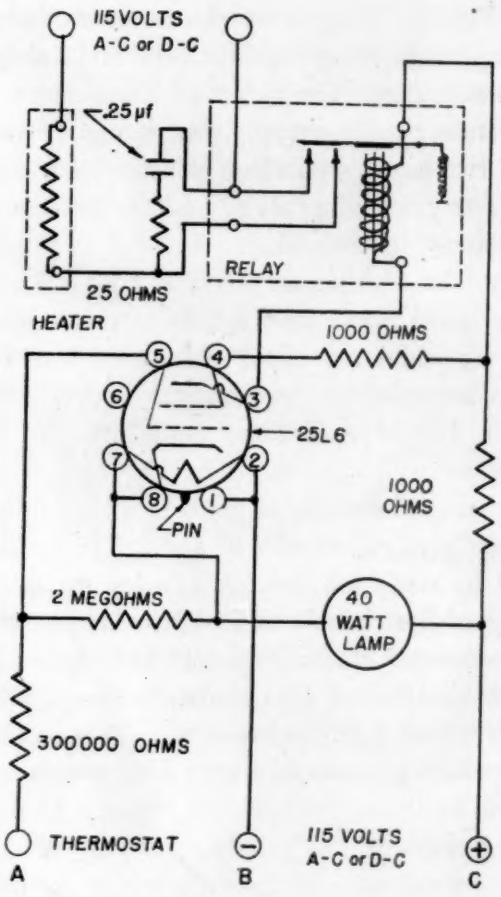

FIG 1

temperature. When the temperature has been increased sufficiently, the contacts in the thermoregulator close the electrical connection between points A and B and thereby make the control grid about 25 volts negative with respect to the cathode. Under this condition the tube has a very high plate resistance, causing the plate current to fall to practically zero. The relay is thus de-energized, its contacts open, and the heating current is interrupted.

The 0.25 μf capacitor is rated for 400 volts d-c and the resistors for two watts. The 25L6-GT tube and its octal socket are sketched as viewed from the tube. The numbers are added to aid in assembling the apparatus simply by reference to the pin fixing the position of the tube in the socket whose No. 6 prong is not used. If it is possible, the point B and the thermostat should be grounded. The current through the heater may be controlled by inserting lamp bulbs or other resistors in series with it. The relay contacts are rated to carry six amperes.

When the device is put into operation and the line voltage applied, the filaments of the tube will require about a minute to reach their operating temperature. The relay will then close if the contact between A and B is open and the tension in the relay spring has been properly adjusted. It is probable that the spring tension will have to be adjusted when the relay is first put into operation, and readjusted if the source is changed from a-c to d-c. Except for a semi-monthly check, the relay needs no attention after this initial adjustment.

The first 25L6 tube lasted nearly two years. The remainder of the apparatus is still in use after operating almost continuously for over three years.

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INEXPENSIVE MICROPHOTOGRAPHIC RECORDS

IN a recent issue of SCIENCE[1] it is suggested that a nail be driven through the lens of a Univex camera in order to obtain a focus with a microscope. I have been using a Univex camera without destroying the lens and without using up the entire film for one picture. If the camera is placed in the same position as the eye after focussing the microscope the camera will be in focus. By pasting a paper or tin tube on the front of the camera it may be placed in position by sliding this tube down over the eye end of the microscope. It is necessary to remove the back of the camera and use ground glass only while pasting on the tube, in order to center it. The tube may be pasted on with so-called "liquid solder" or any other quick-drying nitrocellulose adhesive. If the tube is painted black inside the camera may be used to take pictures of apparatus or experimental animals as well as for photomicrographs.

A label in lead pencil is photographed with the specimen. The time of exposure is usually about 1 second, and about 5 seconds is all that is required to place the camera, make the exposure and remove the camera.

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[1] E. M. Abrahamson, SCIENCE, 91: 510, 1940.

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